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INNOVATIVE TEACHING/ LEARNING METHODS TO IMPROVE SCIENCE, TECHNOLOGY AND ENGINEERING CLASSROOM CLIMATE AND INTEREST

Majda Fiksl,
Andrej Flogie,
Boris Aberšek

Abstract. *For successful work in the classroom, it is important to create a positive climate and to involve students actively in the process of learning. The presented research focused on how the students perceived the classroom climate, and on their interest in the contents of the subject Science, Engineering and Technology (STE). 92 primary school sixth- and seventh-grade students had been included in research. Two groups are established, one from a class using mainly frontal teaching methods (control group) and another, expert group from a class using an innovative teaching/learning methods mainly as problem and research-based learning and participatory learning supported with information communication technology.*
To measure the classroom climate and the students' interest, a survey with 54 statements was used. The results confirmed changes in the perception of classroom climate and in the popularity of contents taught in STE, in relation to the teaching methods used. It was established that innovative teaching/learning methods increase the students' interest, and help to improve classroom climate.

Keywords: *classroom climate, students interest, innovative didactical methods, lower secondary education.*

Majda Fiksl
Primary School Bistrica, Slovenia
Andrej Flogie
Institute Anton Martin Slomšek, Slovenia
Boris Aberšek
University of Maribor, Slovenia

Introduction

For successful teaching and learning process in the school, it is important to increase student motivation, create a positive climate and to involve students actively in the process of learning. The teacher, as the carrier of educational process, is faced with the difficult task of adapting to new demands, of becoming qualified to handle various interpersonal relationships and to work in a classroom with an open, two-way communication. The main task of contemporary schools is to place the student in an active role, and to include innovative teaching/learning methods such as problem-, research- or inquiry-based learning, which are contrary to traditional one-way (frontal) teaching methods. The teacher, therefore, must be a collaborator, adviser and educator, the one that organizes the educational process, teaches students, and uses those kinds of teaching methods, which help the student to consciously, actively, and comprehensively learn the teaching contents and the objectives related to them, while at the same time developing the required skills (Pritchard, 2009; Sharples, et al., 2016).

Since the year 2000, radical changes can be observed in the field of education and training and the basic paradigm of technology-supported teaching, which is transitioning from *technology-oriented learning and teaching to student-centred classrooms* (Dolenc, Aberšek, 2015). While this may give rise to new opportunities, it also requires a different approach to work on behalf of teachers, a different attitude of teachers towards students and towards knowledge in general, i.e., a different kind of school climate. In several studies (Fraser, Fisher, 1983; Westling Allodi, 2002; Ghaith, 2003; Martin, Mullis, Foy, & Hooper, 2016), the effect of classroom climate has been analysed according to teaching strategies, organizational factors, or the student's learning achievements. The research has confirmed that a positive climate in a classroom can only be established through mutual respect, collaboration, two-way communication, participatory learning, and tolerance. The *Teaching and learning international survey* – OECD (2014) lists school climate as one of the most important external factors in education, and emphasizes the fact that school climate is importantly linked to both teaching and learning,

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as well as to students' achievements and learning interest. These statements shall be confirmed or refuted in the presented research.

The theoretical foundations to teaching practice for SET practical classes were founded on the basis of Heimann's (1976) *didactics of learning theory*. According to Heimann (1976) and his model of the didactics of learning theory, also called the Berlin model (Neubert, Biglmaier, 1991), teaching is structured around a core structure comprising six formal characteristics: *goals, content, method, didactic means, anthropogenic characteristics,* and *socio-cultural circumstances*. Teachers and students do not appear explicitly in this structure, although the theory, which builds classroom work upon this structure, highly emphasizes the role and activity of students in the classroom (Aberšek, 2012).

On the basis of Heimann's methodology, an *innovative didactic model S-FBL_SET* (Structural-Functional Based Learning Science, Engineering and Technology) was developed. It is used to ensure discipline and transparency in classes, to direct and carry out classes by means of problem-based and research-based learning (PBL and RBL), and thereby to provide for successful planning, analysis, and assessment of teaching. This model also serves as the basis for the proposed changes, i.e. for the further development and optimization of this innovative teaching model (Aberšek, Borstner, & Bregant, 2014, Fiksl, Aberšek, 2014).

In schools, both cognitive as well as social competences must be developed; working methods must be adapted, and classrooms should provide the kind of teaching/learning climate that enables the students to be as active as possible, and to be able to creatively achieve the goals stated in the curricula. This will support the development of students' creativity and social competences, i.e. the relationship towards their classmates, and towards society as a whole.

The research thus aims at providing an answer to a fundamental research question: *does classroom climate and the students' interest in STE classes that use the innovative didactic model (S-FBL_SET) improve in comparison to traditional, frontal teaching methods*? The answer to this question shall be confirmed or refuted in the presented research.

Methodology of Research

General Background

The research was carried out in lower secondary school SET classes, as part of a thematic set called *Making a product*. To study the effect of the *S-FBL_SET* model on the students' *interest* in the learning contents, and on the *climate* in the classroom, an experimental approach was used. The students were divided into the experimental

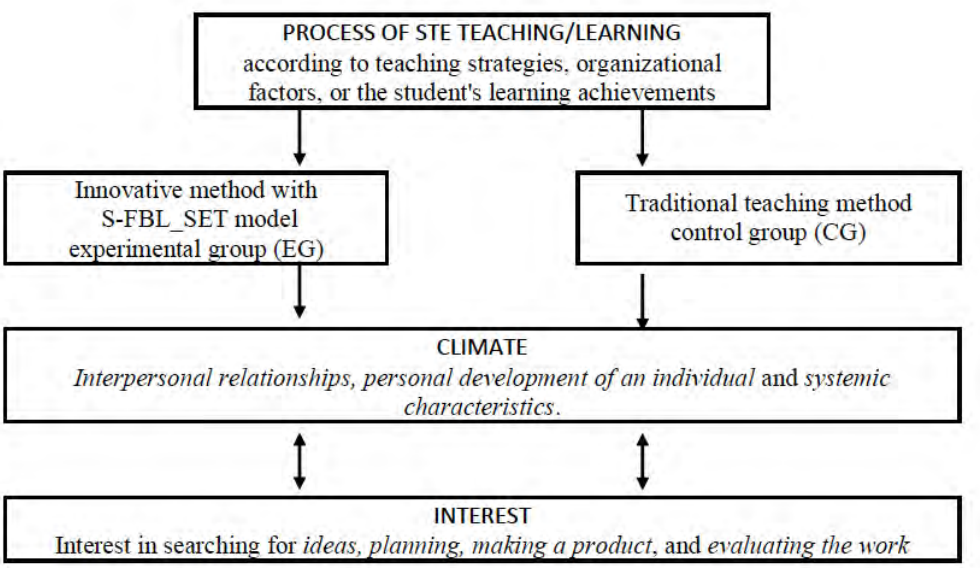

Figure 1: Structure of research.

group (EG) and the control group (CG). The selected group of students represents a simple random sample from a hypothetical population (all students as the selected sample). The first teacher in EG incorporated the *S-FBL_SET* teaching methods, with formative assessment of the results. The second teacher performed the teaching process according to traditional, frontal teaching methods in the CG. The same content was treated in both research groups, the same wooden products were made, and both groups were examined over a time period of twelve school lessons. The structure of the research is schematically shown in Figure 1.

Sample of Research

In the school year 2016/17, 92 students were included in the research, students from two sixth-grade classes (43.5%, N=40) and two seventh-grade classes (56.5%, N=52) from the same lower secondary school, aged between 10 and 11 years. Regarding the gender, the sample contains 42 boys, which equals 45.6% and 50 girls, which equals 54.4%. Regarding the grades in the SET class, one student received the grade D (1.1%), 15 students received a C (16.3%), 44 received a B (47.8%), and 32 students received an A (34.8%). The students were divided randomly according to number, grade, ages and gender, into the CG and the EG, with two teachers (the first teacher in the EG, the second teacher in the CG). Students were randomly distributed so that both research groups contained the same number of students (N=46) according to Table 1.

Table 1. Structure of sample according to gendar, grade, class and researcg groups.

		Experimental group (EG)		Control group (CG)		Together	
		f	*f (%)*	*f*	*f (%)*	*f*	*f (%)*
Gender	Boys	21	22.8	21	22.8	42	45.6
	Girls	25	27.2	25	27.2	50	54.4
Grade	D	0	0.0	1	2.2	1	1.1
	C	6	13.0	9	19.6	15	16.3
	B	22	47.8	22	47.8	44	47.8
	A	18	39.1	14	30.4	32	34.8
School Class	6	20	43.5	20	43.5	40	43.5
	7	26	56.5	26	56.5	52	56.5
Together		46	50.0	46	50.0	92	100.0

Instrument and Procedures of Research

The pilot research started in the school year 2013/2014 (Fiksl, Aberšek, 2014), followed by a thematic-methodological editing, addressing deficiencies and errors, to produce a finalized and improved version of the survey, which was then used in the school year 2016/2017, in SET classes. In both cases (the pilot research and the final research), pre-tests and post-tests were conducted.

For both surveys, two research groups were chosen: the EG, where teaching was conducted following the *S-FBL_SET* model, and the CG, where the frontal teaching method was applied. The research problem was to discover the effect of the proposed innovative didactic model *S-FBL_SET* in Science, Engineering and Technology (SET) lower secondary school classes, from the point of view of classroom *climate* and consequently of the students' *interest*. *Classroom climate* was measured from the point of view of three categories, derived from Moos' theory (1979), and combining the following areas of implementation in the classroom:

- *interpersonal relationships* (connection, satisfaction, inequality, teacher's support, activeness, tension),
- *personal development* of an individual (exploration, competitiveness, difficulty), and
- *systemic characteristics* (variation, rules, goal orientation, organization).

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The students' *interest* in individual technical contents and forms of work as consequences of classroom climate was measured according to the interest in searching for ideas, planning, making a product, and evaluating the work.

The empirical research was thus comprised of four sets of survey questions according to classroom climate:

- What are the differences between students from the EG and CG regarding their interpersonal *relationships*?
- What are the differences between students from the EG and CG regarding their personal *development*?
- What are the differences between students from the EG and CG regarding the *systemic characteristics* of the classroom?
- What are the differences between students from the EG and CG regarding the way they perceive the classroom *climate*?

And as a consequence of classroom climate we add one sets of survey questions according to student's interest:

- Has classroom *climate* influence on the students' *interest* in individual STE contents between students from the EG and CG?

In the survey, standard questionnaires (Fraser, Fisher, 1983; Fraser, Rentoul, 1980) for assessing the classroom climate were used, partially upgraded with our own formulations. The questionnaire was adapted to the field of acquiring skills, as well as to the students' age; therefore, some of the statements were simplified, using only those that correspond in terms of content to the area of our research.

The research data were collected during April, May, and June 2017, by means of a planned survey conducted on sixth- and seventh-grade lower secondary school students. The students filled in the questionnaires for the first time at the beginning of the research, and the same questionnaires once again later, at the end of the conducted research. The approximate time of filling in the questionnaire was 20 minutes; in groups, with a teacher present, who provided the students with detailed instructions. The questionnaire consists of three sections:

- the basic demographic section, which refers to the basic characteristics of the individual interviewee (gender, class, etc.),
- the student's *interest* in individual themes and activities of SET classes in lower secondary schools, the scale consisting of eleven statements divided into four sections (ideas, planning, making a product and evaluating the work),
- 43 statements describing what goes on in the classroom in the sense of perceiving the classroom *climate*; statements are divided into three sections (interpersonal relationships, students' personal development, and inclusion of systemic characteristics into practical classes).

Each category (interpersonal relationships (I_R), personal development (P_D), systematic characteristic (S_C)) is represented by several individual dimensions of classroom climate. Classroom interpersonal relationships are represented by dimensions of connection (5 statements), satisfaction (3 statements), inequality (3 statements), teacher's support (4 statements), activeness in class (4 statements), and tension (3 statements). An individual's personal development is measured by dimensions of exploration (4 statements), competitiveness (2 statements), and difficulty (3 statements). Finally, systemic characteristics are measured by dimensions of variation (3 statements), rules (3 statements), goal orientation (3 statements), and organization (3 statements). The questions in the survey questionnaire were closed-end questions. The students' interest in learning about technical topics was expressed by means of a 5-point Likert scale: 1-dislike very much, 2-dislike, 3-cannot decide, 4-like, 5-like very much. To each of the statements related to classroom atmosphere, the students replied on a five-point assessment scale: 1-almost never, 2-rarely, 3-sometimes, 4-often, 5-very often.

Data Analysis

Microsoft Excel spread sheets in the form of a linear graph were used for graphical data presentation and SSSP for statistical analyses. Questionnaire data were computer-processed on the levels of descriptive and inferential statistics, whereby the following procedures were used (Cohen, 1988):

- frequency distributions (*f, f%*) of the values of selected descriptive variables,

- the arithmetic mean ($\bar{x}$) of numerically expressed degrees of agreement (5-like very much ... 1-dislike very much),
- to establish the reliability of the questionnaire, the method of analysing the inner consistency of the questionnaire was used, with the calculation of Cronbach's alpha coefficient (α); in general, higher values signify a higher reliability of the questionnaire, if this value is higher than 0.60 the questionnaire is reliable enough (under 0.50 – unacceptable, up to 0.60 – low, up to 0.70 – acceptable, do 0.90 – high, above 0.90 – excellent),
- $\chi 2$-test ($\chi 2$, p) of the independence hypothesis for testing differences according to gender, group, and grade (score),
- t-test (*t*, p) for testing differences according to the group in the selected numerical variables of the initial and end states,
- measuring the effect size of Cohen's (*d*) with the criteria (0.20 – small effect, 0.50 – medium effect, and 0.80 – large effect) to establish the practical relevance of statistical findings, whereby effect size is interpreted as the degree of connection between the effect and the dependent variable (Cohen, 1988).

Results of Research

To ensure the necessary internal validity of the experiment, and thereby the possibility of attributing the discrepancies between the EG and the CG, students from both groups have evaluated their *interest* in technical contents and the happening in the classroom in the sense of *climate* (interpersonal relationship, personal development, system characteristic) both before and after their Science, Engineering and Technology classes.

Table 2: t-test results for independent samples of testing the differences in the result of interest and atmosphere (relationship, development, system), according to the group before the experiment.

Group		$\bar{x}$	s	F*	P*	t	p
INTEREST	EG	38.348	8.182	0.076	.783	1.639	.105
	CG	35.478	8.609				
I_R**	EG	73.283	11.475	0.017	.897	-0.812	.419
	CG	75.283	12.136				
P_D**	EG	26.022	5.775	1.071	.303	0.917	.362
	CG	24.804	6.911				
S_C**	EG	38.413	8.060	0.765	.384	-0.535	.594
	CG	39.261	7.126				
CLIMATE	EG	137.717	22.535	0.218	.642	-0.350	.727
	CG	139.348	22.105				

** In all cases, the assumption of homogeneity of variance is justified (p > .05), and therefore the standard t-test was used.*
***(I_R) - interpersonal relationships, (P_D) - personal development, (S_C) - systematic characteristic*

Results of the t-test for independent samples of differences before the experiment indicate (Table 2) that there are no statistically significant differences (p > .05) between EG and CG in the individual categories of atmosphere (relationship, development, system), nor in the common result of measuring atmosphere and interest in the classroom during SET classes. The obtained average values ($\bar{x}$) show (Table 2) that students from EG have evaluated their interest in individual activities, and classroom atmosphere in individual categories (relationship, development, system) during SET classes, similarly to the students from CG. In both compared groups (EG and CG), students evaluated all categories slightly above the midrange number of points. Findings show that there are no statistically significant differences between the groups, and therefore differences between the students from EG and CG do not exist.

After the finalising survey, results were obtained from a statistical testing of differences (*t*-test, Cohen's *d* effect) between EG and CG students, according to individual dimensions of interest, relationship, development, system, and atmosphere as a whole, for the subject of SET in primary school (Table 3).

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Table 3: t-test results for independent samples of testing differences in dimensions of interest, relationship, development, and system, according to the group (EG or KG) after the experiment.

	Group		x̄	s	F*	P*	t	p	d
INTEREST	Idea	EG	7.935	1.181	27.589	.001	5.063 approximation	.001	1.099
		CG	6.109	2.142					
	Planning	EG	12.065	1.665	16.342	.001	6.809 approximation	.001	1.460
		CG	8.870	2.713					
	Making	EG	12.848	1.429	10.776	.001	5.548 approximation	.001	1.178
		CG	10.717	2.177					
	Evaluation	EG	12.674	1.431	12.679	.001	5.973 approximation	.001	1.296
		CG	10.065	2.594					
I_R**	Connection	EG	20.587	2.446	1.750	.001	5.104 approximation	.001	1.096
		CG	17.022	4.058					
	Satisfaction	EG	12.022	1.527	6.813	.011	4.290 approximation	.001	0.915
		CG	10.239	2.368					
	Inequality	EG	7.370	2.195	2.977	.088	-3.801	.001	0.802
		CG	9.457	3.009					
	Teacher's support	EG	16.804	6.054	0.028	.868	2.276	.025	0.491
		CG	14.457	3.507					
	Activeness	EG	16.435	1.809	4.508	.036	2.618 approximation	.010	0.552
		CG	15.261	2.444					
	Tension	EG	7.283	2.167	1.792	.184	-4.359	.001	0.911
		CG	9.413	2.508					
P_D**	Exploration	EG	16.087	2.138	19.394	.001	7.387 approximation	.001	1.617
		CG	11.000	4.153					
	Competitive-ness	EG	8.087	1.208	4.519	.036	6.002 approximation	.001	1.275
		CG	6.174	1.793					
	Difficulty	EG	6.044	1.173	25.687	.001	-3.964 approximation	.001	0.768
		CG	7.696	3.572					
S_C**	Variation	EG	11.130	1.046	6.269	.014	1.559 approximation	.122	0.332
		CG	10.696	1.576					
	Rules	EG	12.457	1.312	14.397	.001	5.533 approximation	.001	1.195
		CG	10.304	2.289					
	Goal orienta-tion	EG	12.696	1.504	14.923	.001	5.716 approximation	.001	1.236
		CG	10.130	2.647					
	Organization	EG	10.109	1.609	9.345	.003	4.626 approximation	.001	0.985
		CG	8.109	2.452					
Climate		EG	157.109	11.850	6.114	.015	5.059 approximation	.001	1.087
		CG	139.957	19.707					

** The assumption of homogeneity of variance is not justified ($p < .05$) in fourteen dimensions (ideas, planning, making, evaluation, connection, satisfaction, activeness, exploration, competitiveness, difficulty, variation, rules, goal orientation, organization), and in the whole case of atmosphere, hence results of the approximation method are listed. For the parameters of inequality, teacher's support, and tension, the assumption of homogeneity of variance is justified ($p > .05$), therefore results of the standard t-test are listed.*
*** (I_R) - interpersonal relationships, (P_D) - personal development, (S_C) - systematic characteristic*

The t-test proved (Table 3), that the difference between EG and CG after the concluded experiment was statistically significant ($p < .05$) for all dimensions of interest, relationship, development, and three dimensions of system. As demonstrated by measuring the effect size of Cohen's *d*, the effect size of the experiment is large ($d > .80$) for all the stated dimensions, except for teacher's support, activeness in class, and difficulty, where the effect size is medium. A statistically significant difference, however, was not proven ($p = .122$) for the dimension of variation, where also the effect size of the experiment, as shown by Cohen's *d* in this respect, is small ($d = .332$). The obtained average values of the evaluations ($\overline{X}$) of interest in Table 3 show that dimensions of inequality, tension, and difficulty, were evaluated lower by students from EG, than by students from CG. All other dimensions were evaluated higher by EG students in comparison to CG students. This means that students from EG perceived less tension and inequality in the group, and a lower level of difficulty of the work, than students from CG.

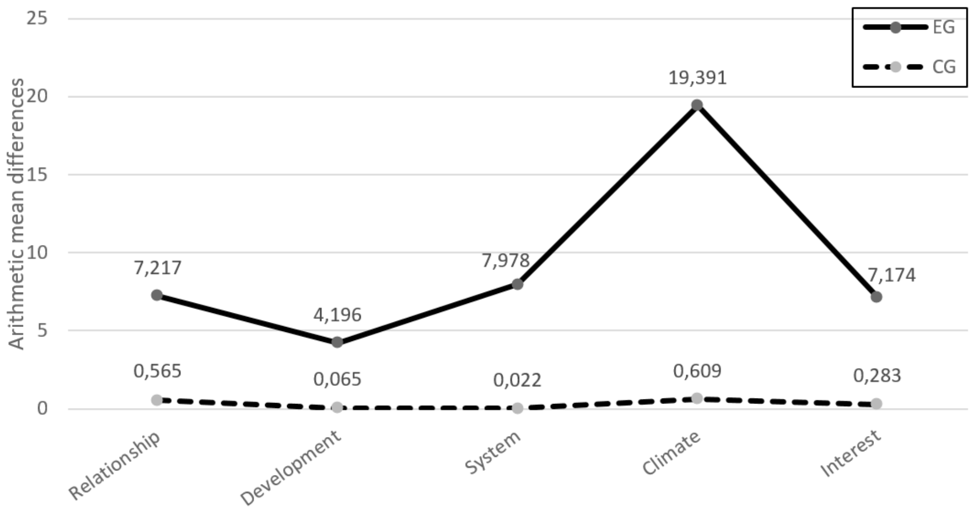

Figure 2: Initial state and arithmetic mean differences for students' *interest* and *climate*, for the expert (EG) and control group (CG).

Figure 2 shows that students from the EG have improved their interest and the perception of atmosphere in all dimensions (relationship, development, system) after the concluded experiment, which is also statistically confirmed below.

Below is an analysis of the students' interest and atmosphere between the initial and end states in the classroom, for the subject of SET in primary school, after the concluded experiment, shown separately (Table 4):

- in the EG - initial and end state and
- in the CG - initial and end state.

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Table 4. t-test results for dependent samples of testing differences between the initial and end states, in the overall and individual result for atmosphere and interest, according to the group.

Group		State	$\overline{x}$	s	$\lvert\overline{x}_z - \overline{x}_k\rvert$	t	p	d
EG	INTEREST	Initial	38.348	8.182	7.174	-7.364	.001	1.191
		End	45.522	3.863				
	I_R	Initial	73.283	11.475	7.217	-5.190	.001	0.729
		End	80.500	8.315				
	P_D	Initial	26.022	5.775	4.196	-7.446	.001	0.943
		End	30.217	3.126				
	S_C	Initial	38.413	8.060	7.978	-8.896	.001	1.445
		End	46.391	2.985				
	CLIMATE	Initial	137.717	22.535	19.391	-8.514	.001	1.128
		End	157.109	11.850				
CG	INTEREST	Initial	35.478	8.609	0.283	-1.241	.221	0.034
		End	35.7609	7.995				
	I_R	Initial	75.283	12.136	0.565	-1.453	.153	0.049
		End	75.848	10.768				
	P_D	Initial	24.804	6.911	0.065	-0.443	.660	0.010
		End	24.870	6.520				
	S_C	Initial	39.261	7.126	0.022	0.072	.943	0.003
		End	39.239	6.353				
	CLIMATE	Initial	139.348	22.105	0.609	-0.988	.328	0.029
		End	139.957	19.707				

In EG the *t*-test proved (Table 4) that the difference between the initial and end states is statistically significant ($p < .05$) for interest, relationship, development, system, and atmosphere, as an overall result ($p = .001$). As shown by measuring the effect size of Cohen's *d*, the size of the experiment is large ($d > .80$) for the categories of development ($d = .943$), systemic characteristics ($d = 1.445$), and atmosphere as a whole ($d = 1.128$). The smallest effect size, a medium one, was demonstrated for relationships ($d = .729$). Arithmetic means ($\overline{X}$) show that the initial state in all categories is lower in comparison to the end state. At the end of the experiment, students from EG demonstrate a higher level of interest in the contents, and a better perception of the relationships, development, system, and atmosphere as a whole. Results of arithmetic mean absolute differences' test ($\lvert\overline{X}_z - \overline{X}_k\rvert$) in the EG have shown that on average, students have a lower consistency as regards systemic characteristics in the classroom (variation, rules, goal orientation, organization), and a higher consistency as regards the individual's personal development (exploration, competitiveness, difficulty). After the concluded experiment, EG students perceived a greater difference in systemic characteristics than in development.

A statistically significant difference between the initial and end states of the experiment was not proven ($p > .05$) in the CG for interest ($p = .221$), relationship ($p = .153$), development ($p = .660$), system ($p = .943$), and atmosphere as a whole ($p = .328$). Indeed, as shown by Cohen's *d*, the effect size of the experiment is a small one for all categories from this point of view. Arithmetic means ($\overline{X}$) show (Table 4) that the initial state in all categories was evaluated similarly as the end state. Results of arithmetic mean absolute differences' test ($\lvert\overline{X}_z - \overline{X}_k\rvert$) in the CG show that there were no statistically significant differences between the initial and end states, since the differences in derogations are very small. There were almost no differences perceived between students from the control group (CG) before and after the concluded experiment, which was expected, since no additional changes were introduced to the classes.

Discussion

This research was concerned with 5 set of research questions about whether there are differences between teaching/learning methods using in the expert (EG) and the control group (CG) regarding the 1. students' interest, 2. interpersonal relationships, 3. individual's development, 4. systemic characteristics, and the 5. classroom climate as a whole. The parameters were treated separately, considering the initial and end states of the experiment.

Considering the initial state before the experiment it was concluded that there are no statistically significant differences between the compared groups (EG and CG), therefore differences between EG and CG students do not exist (Table 1). Before the experiment, both groups (EG, CG) display a similar level of interest and attitude towards the content of their STE classes, and also perceive the classroom climate similarly, in terms of relationships, development, and system. From the point of view of further processing of data related to the end state of the experiment, this is a favourable starting point for post-experiment group comparison.

Considering the final state after the experiment it was concluded that there are statistically significant differences present between the groups EG and CG, both in the category of interest and awareness, as well as in all categories of a climate (interpersonal relationship, personal development, system characteristic), individually and overall. Following a detailed statistical analysis of the individual dimensions of interest, relationship, development, and system, we can summarize the most important empirical findings.

Interest: in testing the effects of the modern didactic model *S-FBL_SET* on students interest it was concluded that a statistically higher interest is demonstrated by EG students, which is confirmed by similar research (Cohen, Mccabe, Michelli, Pickeral, 2009; Feaser & Fisher, 1983, Dumont, Istance, & Benavides, 2010, Kordigel Aberšek, 2012). Students from the EG have demonstrated a greater interest in coming up with ideas, planning, making, and evaluating a product. The greatest difference between the groups was related to the planning of a product, which can be attributed to the teacher's explaining of the theoretical part during the (hand-)making of the product itself. The smallest difference was observed in evaluating the product, where students calculated the costs of making the product, which was a rather demanding and less interesting task for them.

Interpersonal relationships: between the groups EG and CG, a statistically and practically significant difference is confirmed for four dimensions of relationship (connection, satisfaction, inequality, tension). Further, a statistically significant difference is confirmed for two dimensions of relationship (teacher's support, activeness). In the EG a greater connection was perceived by the students, a greater level of satisfaction while working, more teacher's support, and more active participation during the classes. The results are partly consistent with findings from previous research (Monsen in Frederickson, 2004). Moreover, less tension and less inequality were also perceived in the classroom, which means that the teacher motivated all his students, and not expose individuals. The greatest difference between the groups (EG and CG) is present regarding connection (friendship, group work). Similar findings have been discovered by other research (Cohen, Mccabe, Michelli, Pickeral, 2009, OECD, 2009), a sense of connection is highest with younger students, with age, they become more critical. The smallest difference concerns the level of students' activeness during classes (medium effect size).

Personal development: a statistically and practically significant difference is also confirmed for all dimensions of development (exploration, competitiveness, difficulty). In EG the students perceived more chances to explore and a higher level of competitiveness, but a lesser difficulty level of schoolwork. There is a very large difference between EG and CG regarding the parameter of exploration, which can be attributed to a greater activeness of the students and the teacher, while searching for an idea for a product. A smaller difference between EG and CG was confirmed regarding the difficulty of the work, where the effect size was medium. This means that the performance-oriented climate in both groups was similar, and was evaluated by the students with an average of 3 points on a scale from 1 to 5 (not difficult, not easy). Students from the CG were considerably less unanimous in assessing the level of difficulty, as compared to students from the EG. A perceived lesser difficulty is confirmed by studies by (Cohen, Mccabe, Michelli, Pickeral, 2009; Feaser & Fisher, 1983, Dumont, Istance, & Benavides, 2010) which is attributed to instruction-guided teaching and asking questions.

Systemic characteristics: a statistically and practically significant difference is also confirmed for three dimensions of system (rules, goal orientation, organization). In EG the students perceived a greater level of goal orientation (they know exactly what to do and how to do it), clearly defined rules during work, and good organization (they are not bored during classes). Cohen, Mccabe, Michelli, Pickeral, (2009, Westling Allodi, 2002) perceives clarity of rules as higher with younger students. A statistically and practically significant difference, however, was not confirmed for the dimension of variation. On average, students from both groups (EG and CG) agree that they prefer

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to work in class, if something interests them, and at the same time, that they sometimes make an effort only to get a better grade. The students should relate their feeling of success to their work and their persistence (Dweck, 2006), not to the grade.

Climate: in the perception of classroom climate, a statistically and practically significant difference is demonstrated for all categories of atmosphere in the EG. Results show that, following the modern didactic model *S-FBL_SET*, a positive learning environment can be created, and a climate can be provided in the classroom, which is equally good or even better than the existing, which was confirmed by OECD (2009, 2013, 2014) research. Classroom climate was rated highly by both research groups (EG and CG), all average values were evaluated at least slightly above the midrange number of points, which is consistent with the findings of (Cohen, Mccabe, Michelli, Pickeral, 2009; Feaser & Fisher, 1983, Dumont, Istance, & Benavides, 2010), that the perception of classroom atmosphere diminishes, as the students progress to higher grades, i.e. with years of schooling. The highest level of perception was observed in primary schools, whereas in secondary schools the differences are lesser and lesser.

All five sets of the research questions posed were answered. The results show that teaching students using didactic methods on the basis of the *S-FBL_SET* model, had a positive impact both on the students' interest in individual contents of the subject, as well as on all categories of classroom climate, according to relationships, personal development, and systemic characteristics. In Slovenia, the positive effect of various teaching models in natural sciences has been confirmed by the research work of Pešaković, Flogie and Aberšek (2014), Vieluf, Kaplan, Klieme, Bayer, (2012) and OECD (2009).

Conclusions

To sum up the results of the analysis of improvements in the perception of classroom *climate* and the students' *interest* in individual contents in their Science, Engineering and Technology classes, it can be concluded that in the conditions of statistically controlled variables of climate and interest, the experiment had a positive effect. Students from the EG had better interpersonal relationships, their personal growth was enhanced, they were better organized in the classroom and demonstrated a greater interest in the contents, which led to a greater popularity of the subject, a more pleasant climate, improved attitudes towards learning, and a general improvement in the well-being of the students. Drawing designs for their products with the help of the computer became more popular among the students, as well as getting to know the more technical aspects during the process of work. It could be concluded that group work encourages better collaboration and places a greater importance on friendship, as the students learn to help each other with their work. On the other hand, a small difference was observed between the groups regarding the students' activeness, and the level of difficulty of the schoolwork. Teachers should be actively shaping the learning environment so that it listens to and guides the students, praises them for their participation, encourages them, and takes effort and persistence into account when assessing. This may well be the cause behind the fact that no difference was observed between the research groups regarding variation between students. In planning and designing classes, the students' interests must be considered, the subject matter brought closer to them, and they should be guided towards building their own knowledge based on previous experience.

Transferring theory to practice with the help of an advanced learning environment, following the progressive *S-FBL_SET* model, provides teachers with an innovative approach to teaching Science, Engineering and Technology, which is more student-oriented and at the same time ensures and promotes high-quality teaching and learning. Changes in schools, therefore, are definitely possible, if the teachers truly feel the need for change, if they provide the time and approach this task with commitment and the appropriate knowledge. We can conclude that SET classes organized in such a way meet one of the basic conditions for acquiring high-quality knowledge and skills, from various perspectives of organizing the educational process in lower secondary school grades.

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Majda Fiksl Primary School Bistrica, Begunjska 2, 4290 Tržič, Slovenia.
E-mail: majda.fiksl@guest.arnes.si

Andrej Flogie Institute Anton Martin Slomšek, Vrbanska 30,
2000 Maribor, Slovenia.
E-mail: andrej.flogie@slomskov-zavod.si

Boris Aberšek PhD, Professor, University of Maribor, Faculty of Natural Science and Mathematics, Koroška 160, 2000 Maribor, Slovenia.
E-mail: boris.abersek@um.si